Implementation in Pakistan of the US Integrated Cargo Containers Control program: Trade-facilitating or not?

Salamat Ali
University of Nottingham,GEP

Richard Kneller
University of Nottingham,GEP

Chris Milner
University of Nottingham,GEP

Abstract. Using novel firm-level data, we examine the trade effect of the changed security arrangements for Pakistan's exports to the US following 9/11. The pre-shipment scanning facility introduced by the Integrated Cargo Container Control (IC3) program, following the 100% scanning requirement, affected the beyond-the-border and behind-the-border costs of exporting. We exploit the exogenous nature of this shock and its specificity to one export market in the identification strategy. The estimates show Pakistan's exports dropped by between 8% and 11% because of IC3 but that the effect was heterogeneous across firms depending upon their pre-IC3 port of departure and whether they switched following IC3. We also show that the export fall would have been even greater if 100% scanning had been introduced without a pre-shipment scanning facility.

Résumé. Mise en place du Programme de contrôle intégré des conteneurs de fret au Pakistan : aide ou inconvénient au commerce? Dans le sillage des événements du 11 septembre 2001, et grâce à de nouvelles données d'entreprises, nous examinons les conséquences commerciales liées aux modifications sécuritaires s'appliquant aux exportations pakistanaises à destination des États-Unis. Le dispositif de scannage préalable avant expédition, introduit par le Programme de contrôle intégré des conteneurs de fret (programme IC3) et respectant les exigences de scannage intégral, eut des conséquences sur les coûts d'exportation en amont et en aval des frontières. Afin d'établir une stratégie d'identification, nous exploitons la nature exogène de ce choc ainsi que sa

*Corresponding author: Richard Kneller, richard.kneller@nottingham.ac.uk

The authors wish to thank Shafqat Ali Khan in his role as a customs official at Port Qasim, Karachi, Pakistan; Zafar Iqbal in his role as as a senior preventive officer in charge of scanning operations at IC3, Pakistan; Muhammad Saad Zulfiqar in his role as manager of the Helpdesk and Customs Affairs, DP World–Karachi; and representatives of shipping lines (Maersk, Safemarine, UASC and APL) at Port Qasim for their insights in the preparation of this paper.

Canadian Journal of Economics / *Revue canadienne d'économique* 2021 0(0)
xxxx 0000. Printed in Canada / *xxxx 0000. Imprimé au Canada*

ISSN: 0008-4085 / 20 / pp. 1–32 / © 2021 The Authors. Canadian Journal of Economics/Revue canadienne d'économique published by Wiley Periodicals LLC on behalf of Canadian Economics Association

spécificité propre à un marché d'exportation particulier. Nos estimations montrent qu'en raison de la mise en place de l'IC3, les exportations pakistanaises diminuèrent de 8 à 11 %. Néanmoins, l'effet s'est avéré hétérogène pour les entreprises en fonction de leur port d'expédition avant l'IC3, et le cas échéant, de leur nouveau port d'expédition après l'IC3. Nous montrons également que les exportations auraient chuté davantage si le scannage intégral avait été introduit sans un système de scannage préalable avant expédition.

JEL classification: F1, F13, F14

1. Introduction

IN A WORLD where the threats to national security are globalized, transportation networks have been recognized as a weak link that could be exploited to ship the technologies of terrorism internationally (Meade and Molander 2006, OECD 2005). The reliance of international trade on these same networks highlights an importance in understanding and quantifying the trade effects that arise from policy responses to counter this terrorist threat. A typical assumption is that inevitably these additional security requirements must be trade impeding. However, on occasion, such as the one we study, they can also lead to an upgrade in the technology used by border agencies, potentially boosting trade. Whether their use is sufficient to offset any negative effects is, ultimately, an empirical question.

Evaluation of the design and implementation of counterterrorism policies is made difficult by the fact that countries do not alter or adopt new security policies randomly but rather do so in response to the actual or perceived threat of terrorism, confounding variables that can additionally affect trade flows directly or indirectly through numerous channels (Mirza and Verdier 2008). In this paper, we provide such analysis by exploiting the quasi-experimental setting that followed from the imposition of a new counterterrorism policy on Pakistan by the US that arose from the events of September 11, 2001, (commonly known as 9/11) and the terrorist threat posed by its neighbour Afghanistan.

In the period following the 9/11 terrorist attacks, the US administration conducted several reviews of national security policy.[1] The fear that containerized cargo could be used to smuggle radioactive or nuclear materials into the US through vulnerable countries such as Pakistan featured heavily in this analysis. The policy responses were numerous[2] and extended beyond exports destined for the US from Pakistan. The 9/11 Commission Act of 2007 required

1 These include the National Commission on Terrorist Attacks on the United States (also known as the 9/11 Commission) as well as Meade and Molander (2006).

2 These include the Aviation and Transportation Security Act (2001), the Homeland Security Act (2002) and the Maritime Transportation Security Act (2002).

100% scanning of US-bound exports from *all* countries, with 2012 set as the date for full implementation. There are, therefore, some potential wider lessons from the Pakistan experience for other countries, but the timing and nature of the measures applying in the case of Pakistan were specific to the Integrated Cargo Container Control (IC3) program. Following the passing by the US Congress of a law requiring mandatory screening and scanning and starting in 2007, the program involved the live monitoring of the scanning of containers for radioactive and contraband items in Pakistan by the National Targeting Centre (NTC) in Washington, DC, via a video link (Government Accountability Office 2008). Once Washington gave security clearance, the container was allowed to enter the US without further checks. The scanning technology made available by the US to the Pakistan authorities was sufficient for its use at a single port, which was chosen to be Port Qasim (see maps in the online appendix for location of this port). In the year prior to IC3, Port Qasim accounted for around 35% of Pakistan–US freight.

For US-bound freight, the availability of pre-shipment scanning was expected to reduce beyond-the-border trade costs compared with the pre-IC3 period and compared with non-US bound freight. Pre-IC3 Pakistan's exports to the US were subject to random interception and diversion to ports in Sri Lanka, Hong Kong or Oman for scanning.[3] Table 1 reports on the comparison of shipping distances and times from Pakistan to the US (New York and Los Angeles) with (possible pre-IC3) and without (certain post-IC3) diversion to one of the above international ports for scanning. For shipments to New York, for example, the shipping distance is nearly 20% shorter and saves six days in sailing time with diversion to Sri Lanka avoided. Indeed, for this reason the program was viewed and presented ex ante as trade-promoting by the Pakistan government and others. "The implementation of the IC3 will reduce the cost of country's exports to the US. Presently, all cargoes destined for US from Pakistan are trans-shipped to Hong Kong, Colombo and Salalah for scanning, resulting in delay and extra financial cost to the exporters. The facility will also help exporters save time and money" (The News International 2007).

Focusing on beyond-the-border costs does not, however, accurately capture all of the effects of the program on overall trade costs, which also include at-the-border and behind-the-border costs. This point is often neglected in estimates of the effects on counterterrorism policies on international trade. In fact, at-the-border and behind-the-border trade costs rose as a consequence of IC3, principally from the way IC3 was implemented. Most obviously, they rose because of the time taken to complete the 100% scanning requirement (at the border or on route) compared with the probabilistic stop and search (on

3 The exception to this was less-than-full-load containers that could continue to be shipped through non-Port Qasim ports such as the Port of Karachi. For these routes, beyond-the-border trade costs rose because of the mandatory scanning requirement as a transhipment port.

TABLE 1
Maritime distances and vessel sailing time to the US in the pre- and post-IC3 periods

Destination	Direct shipments	Via transshipment ports					
		Sri Lanka		Hong Kong		Salalah (Oman)	
	KM	KM	Diff. (%)	KM	Diff. (%)	KM	Diff. (%)
A: Maritime distance (km)							
New York	14,812	18,424	−19.60	28,591	NA	14,852	−0.27
Los Angles	19,564	19,756	−0.97	19,828	−1.33	21,754	−10.07
B: Vessel sailing time (days)							
Destination	Days	Days	Diff.	Days	Diff.	Days	Diff.
New York	24	30	−6	45	NA	25	−1
Los Angles	31	32	−1	32	−1	35	−4

NOTE: Diff. = difference.
SOURCE: SeaRates, `www.searates.com/reference/portdistance/`

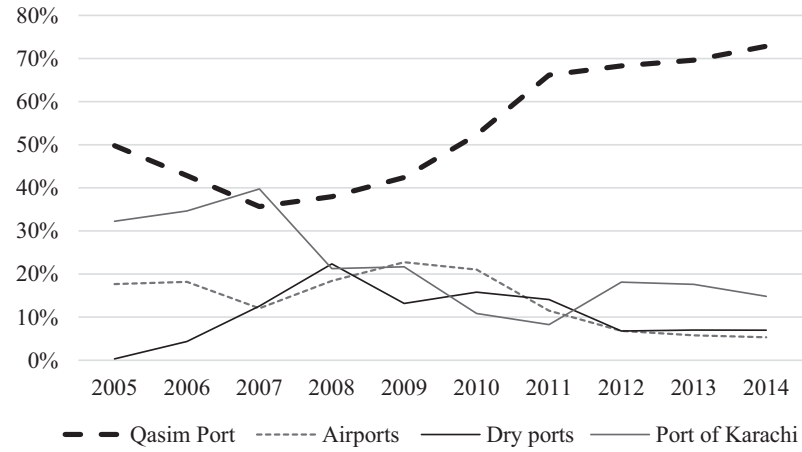

FIGURE 1 Internal diversion of US-bound export cargo to Port Qasim because of centralization of scanning operations, 2005–2014
NOTE: Values on the y-axis are the trade shares of various export-processing stations in the total US-bound exports.
SOURCE: Authors' calculations using data of Pakistan Customs

route) approach used previously. They also rose because of the congestion caused by technology being available only at a single outbound port. For freight previously routed through other ports in Pakistan, exporters had the choice to transfer cargo through Port Qasim or continue to use other ports. Figure 1 reports on the proportion of US-bound exports each year from alternative ports in Pakistan for the period from 2005 to 2014. Note the marked rise in the proportion from Port Qasim after 2007, rising from less than 40% in 2007 to nearly 70% by 2011. The journey to Port Qasim via road was longer to and around Karachi compared with the route to the Port of Karachi (see

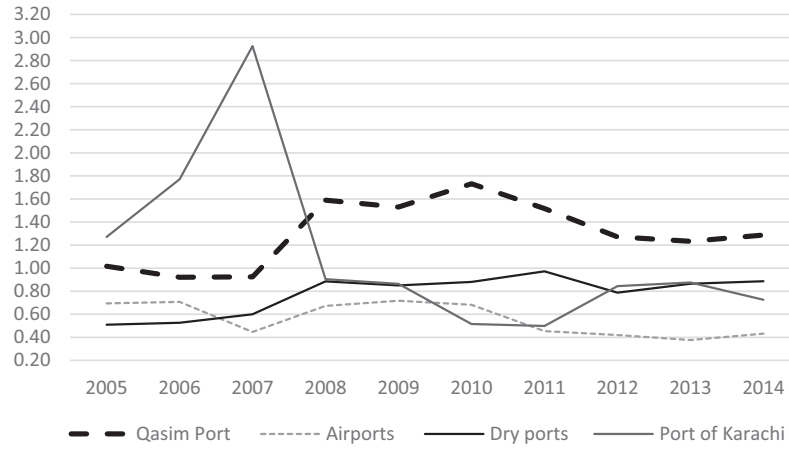

FIGURE 2 Relative share of US/EU exports by customs station, 2005–2014
SOURCE: Authors' calculations using data of Pakistan Customs

maps in online appendix figures A.1 and A.2). In figure 2, we report the relative share of exports to US/EU by customs station. Again, important for the analysis, we find that the share of exports to the US using Port Qasim rises relative to EU exports using the same port in the post-IC3 period. We find that these shares were almost equal before 2007. We also find that the share of US-bound exports using the Port of Karachi, which was greater than the share of EU exports using that port pre-IC3, falls relatively in the post-IC3 period.

Table 2 summarizes the increase in internal road distances for exports diverted from the Port of Karachi to Port Qasim for firms located in different cities in Pakistan. The average internal distance that exports were transported rose by about 5% (in unweighted terms) and by 9.3% when weighted by export values from the different locations. The distance-raising effect was greater for export firms closer to Karachi (where the majority of exporters were located), doubling the distance to the outbound port for firms in Karachi but increasing it by only 3.4% for firms in Peshawar (firms here, on average, being over 1,600 km from both ports). Therefore, for those firms that switched to exporting through Port Qasim, behind-the-border trade costs rose because of the longer domestic journey times. These higher costs were ameliorated to some extent by adjustments to the implementation of the program in 2011 through expansion of port infrastructure and scanning, which we control for in our empirical analysis. For firms that continued to use ports other than Port Qasim, shipping times rose because of the longer distances involved on average with transshipment via a foreign port and the required scanning at the port. Behind-the-border and at-the-border costs were, however, unchanged in this case. To disentangle questions about the trade effects of the pre-clearance scanning from those of the additional (within- and beyond-border) transport costs

TABLE 2
"Behind-the-border": Increases in internal distance to port for diverted exports

Export origin:	Distance to ports (in km)		% increase	Export weight 2009
	Karachi	Port Qasim		
(1)	(2)	(3)	(4)	(5)
Faisalabad	1,188	1,243	4.6	0.123
Gujranwala	1,345	1,400	4.9	0.010
Hyderabad	147	202	37.4	0.001
Islamabad	1,506	1,561	3.7	0.001
Karachi	55	110	100.0	0.532
Lahore	1,265	1,320	4.3	0.149
Multan	943	998	5.8	0.004
Peshawar	1,601	1,656	3.4	0.000
Quetta	670	725	8.2	0.019
Rawalpindi	1,501	1,556	3.7	0.001
Sargodha	1,396	1,451	3.9	0.000
Sialkot	1,219	1274	4.5	0.161
% increase				
Simple average	1,070	1,125	5.1	15.3
Weighted average	593	648	9.3	55.4

NOTES: Columns (2) and (3) contain shortest road distances from centre of towns to seaports measured with the Google Maps. Column (5) contains export weights for 2009.
SOURCE: Authors' calculations

imposed on some exporters, we rely heavily on the transaction-level trade data available to us and on information about firms' port for shipment and their within-country location.

In the next section of the paper, we lay out in more detail the motivation, design, introduction and the equipment used for this change in counterterrorism policy and how it affected trade costs with the US but not those to other international markets. We use the insights as a motivation to study the trade effects of the IC3 program using a difference-in-differences (DID) framework, with Pakistan's trade with EU countries as a counterfactual.[4] For the question we study, there are a number of advantages to the use of the DID approach alongside customs data on exports that vary by firm, product and time. First, by design, the application of a DID framework helps to remove changes to trade flows to all Western countries that are explained by any changes in the perception that Pakistan was a source of terrorism from neighbouring Afghanistan. Secondly, it does not require that the adoption of IC3 and location only at Port Qasim be exogenous, only that it was so from the perspective of Pakistan's exporters—a reasonable assumption given the small average size and low international market power of these firms.

4 Its timing was also difficult to anticipate owing to delays in funding (The News International 2007).

A third advantage draws on the ability to observe exports of different products to different destinations by the same firms at different points in time. This allows us to add many different combinations of firm, product, market and time fixed effects in order to control for the effects of other possible macro- and micro-level confounding influences that might otherwise explain our results, sharpening the identification of the effects of IC3. Macro-level influences could include improvements in domestic export policy, technology, infrastructure and other institutional changes that could have affected trade flows to both destinations in this period. To also remove the effects of unobservable time-varying firm-specific factors, we present results where the effects of IC3 are identified from the change in export values between the US and EU markets within the same firm and within the same year.

A final advantage from the data comes from our ability to observe the location of the exporter within Pakistan. Our base modelling specifies the counterfactual so as to evaluate the implementation of the changed security and clearance options as a whole, i.e., to evaluate the effect of the 100% scanning requirement and the provision of a pre-shipment scanning facility at Port Qasim relative to Pakistan's trade with the EU (which was not subject to either the scanning requirement or the pre-clearance facility). Given that our data allow us to distinguish between firms that decided to use the pre-shipment scanning facility and those that satisfied the 100% scanning requirement at a non-Pakistani port, in the paper, we consider indirectly the alternative counterfactual, namely the trade effect of the introduction of the 100% scanning requirement without the use of the pre-shipment clearance facility. For brevity, we use the label IC3 to refer to the combined 100% scanning requirement and the possible use of pre-shipment scanning, but in this later heterogeneity analysis, we seek to explore the effects of the scanning requirement and pre-shipment clearance facility separately.

The base modelling identifies a fall in exports relative to the counterfactual, one that is statistically significant. This is consistent with an interpretation that the implementation of IC3 raised overall trade costs to the US for Pakistan exporters. Of the various types of firm–product–destination–time effects that we add to the regression, the estimated effect of IC3 displays the greatest sensitivity to the inclusion of controls for time-invariant firm–destination effects in the estimation, halving it compared with a regression without these controls. This helps demonstrate the value of using highly disaggregated trade data compared with using standard data on bilateral trade flows to answer a question about the effects of IC3.[5] Beyond the controls for

5 We show evidence in the paper on an effect on Pakistani exports when using COMTRADE data that is of a similar magnitude to that found when using Pakistani customs data and a regression with no firm–destination fixed effects (table 4).

firms and destinations, there is much less sensitivity compared with the initial estimates, indicating that other types of confounding factors are not an issue.

We also provide evidence of the robustness of the main findings to the use of China as an alternative counterfactual or control, and search for evidence that there may be confounding trade diversion from the US to the EU markets by distinguishing between the IC3 effect for firms that had previously served both markets and those firms that had exported to the US only pre-IC3.[6] We find some evidence consistent with such an outcome, although the effects are very modest and cannot explain our main findings. We also systematically investigate whether our findings are driven by other confounding factors such as military involvement by the US and some EU countries in Afghanistan over this period. These additional tests indicate that our findings about the IC3 effect are robust.

We further use the richness of the international trade data available to us by separating the effects of IC3 into the adjustments that occur for firms that used Port Qasim prior to the introduction of IC3 versus those that had previously used other ports. Consistent with figure 2, we show that the mandatory scanning requirement and concentration of the scanning operations at Port Qasim led many firms to switch away from their previous port of shipment. Using information on their pre-IC3 use of Port Qasim versus alternative ports, including dry ports, we are able to show that the negative effects of IC3 were confined to the non-Port Qasim users. For firms that had used Port Qasim pre-IC3, we find no evidence of a significant drop in exports relative to the counterfactual. This evidence indicates that it was not the introduction of a domestic scanning capacity per se that had a negative effect on trade but rather its availability at only a single outbound domestic port that was export-reducing. The drop in trade for firms that switched to Port Qasim after IC3 is greatest for the first four years of the program, from 2007 to 2011. The port expansion in 2011 offset these negative effects to some extent, although their net effects over the whole post-IC3 period remain negative.

The disaggregate results also allow us to comment upon the question "What if 100% scanning had been applied by the US to Pakistan exports

6 There is a high degree of product overlap in the composition of Pakistan's exports to the US and EU (see figure 2), with relatively high-value finished exports to these two high-income markets with similar growth rates. By contrast, Pakistan's exports to China tend to be raw material and semi-processed goods. This similarity of export composition makes the EU a better control. It may also mean, however, that there is more scope for trade diversion between the US and EU than between US and China with change in Pakistan's relative bilateral trade costs. Interestingly, we find a greater IC3 effect when China is used as the control. Given this and the limited evidence of contamination of trade with the control by the treatment (IC3), we present the findings with the EU as the control as our base, preferred findings.

without the creation of a pre-shipment scanning facility?" We find that those firms that continued to export from other than Port Qasim and were required to increase international transport distances and times in order to be scanned at an international port experienced the largest trade destruction effect. Indeed, the trade destruction effect for these firms was more than twice as large as that experienced by those firms that switched to exporting from Port Qasim in order to meet the scanning requirement.

This research extends the narrow stream of literature on trade and security issues (European Commission [EC] 2009, Government Accountability Office 2008, Mirza and Verdier 2008, World Customs Organization [WCO] 2009). Mirza and Verdier (2008), in a general analytical framework, describe the existing relationships between terrorism, counterterrorism actions and trade and argue that terrorism affects trade flows primarily through two channels: reducing the willingness to do business with insecure countries and the trade-restrictive effect of counterterrorism policies. Our paper provides empirical evidence of these channels related to firm-level exports. Similarly, the EC (2009), WCO (2009) and Government Accountability Office (2008) argue against the feasibility of 100% scanning of US-bound exports owing to the high costs associated with the internal movement of cargo, congestion at ports and associated infrastructural constraints. Although these studies found the scanning operations to be highly cost-intensive and trade-restrictive, they did not perform quantitative assessments of the magnitude of the trade-restricting impact because of data limitations. We bridge this gap by using an administrative data set to estimate the trade effect of IC3 and examine its heterogeneity along multiple dimensions at a micro level.

Our findings add to the various strands of literature on technology and trade, trade costs and trade diversion. The recent literature on technology and trade examines the effect of containerization (Bernhofen et al. 2016) and maritime transport (Hummels 2007, Pascali 2017), whereas this paper explores the effect of intrusive scanning technology, which is increasingly being adopted for security and trade facilitation purposes. The trade diversion literature examines primarily the changes in importing countries' trade patterns in the context of preferential trade agreements (PTAs) and free trade agreements (FTAs) (e.g., Carrère 2006), whereas we explore the effect on the exporting country's trade flows due to the cost-raising effect of the security policy. This trade diversion effect of behind-the-border costs also speaks to the vast literature on trade costs (Anderson and Van Wincoop 2003, 2004; Arkolakis 2010; Baier and Bergstrand 2007; Donaldson 2018; Feyrer 2009). In contrast to these studies, we isolate the effect of this shock from other potentially omitted variables influencing exports during this period by finding a suitable counterfactual group. Finally, our results highlight a connection between pre- and post-shipment time costs and exports. In this regard, this

paper can be seen to support the findings of Djankov et al. (2010) about the importance of time delays as a determinant of international trade.[7]

The remainder of the paper is structured as follows. The next section introduces the data, describes the empirical setting and the estimation methodology. Section 3 presents the main estimation results and section 4 the robustness checks. Section 5 concludes by highlighting the policy implications of the study.

2. Data and estimation framework

2.1. Data

The study uses data on international trade from Pakistan Customs.[8] This data set contains transaction-level information, including firm identifiers, product codes, prices and quantities at an eight-digit Harmonized System (HS) code level, in addition to the identities of export processing stations and modes of shipment. It includes all product categories in manufacturing and the agricultural sector, and covers the universe of firms shipping from through dry ports, airports or seaports to 215 trading partners of Pakistan. From this larger data set, we focus on Pakistan's exports to the US and EU markets.[9]

The cleaned data set of Pakistan's exports to the EU and US contains 6.1 million transactions (3.8 million for the EU and 2.3 million for the US) for 24,174 firms, of which 20,297 exported to the EU and 11,737 to the US during the 2002–2014 period. This long time span covers seven years

7 Methodologically, we choose a different approach from the one used by this paper. While these authors also use a difference-in-difference strategy, they focus on differences in time costs according to the time sensitivity of the product. In this paper, we instead exploit the fact that IC3 applied to trade for one country to one destination but not others. We are also able to use differences in the location of exporters and their distance to Port Qasim. This has some similarities with the instrumental variable approach adopted by Djankov et al. (2010).

8 Use of this data set is subject to a confidentiality agreement. Most of the information, however, is available from the Exporter Dynamic Database of the World Bank.

9 We take the EU (28) for this purpose, i.e., consider that the countries acceding during the period were already members from 2002. This allows us to hold the control grouping of countries constant. In fact, there was pre-membership convergence to EU trade policy by new members as part of their accession process. As part of the robustness analysis, we form a control grouping that includes only pre-2002 EU members (see table 5 and accompanying discussion). It should also be noted that Pakistan's exports to the EU (28) were dominated throughout by exports to pre-2002 members, with the post-2002 new members accounting for a small and fairly constant share (around 7% to 10%) of Pakistan's exports to the EU (28).

prior to and seven years after the launch of IC3. For ease of estimations, we collapse the data to the firm–product–market–year level. The final data set, therefore, covers 606,351 observations, of which 458,838 pertain to the EU and 147,413 to the US. We test the integrity and accuracy of the data by performing aggregation tests and comparing the results with the same information retrieved from the UN Comtrade data set. The remaining information on other economic variables has been retrieved from the open data sources of the World Trade Organization (WTO) and the World Bank.

2.2. Estimation framework

To quantify the magnitude of the trade effect of the first intervention at the firm level, we use the standard difference-in-difference regression framework, which in its most basic form can be expressed as follows:

$$ln(X_{ijkt}) = \beta_0 + \beta_1 US_j + \beta_2 TIME_t + \beta_3 IC3_{jt} + \varepsilon_{ijkt}, \quad (1)$$

where i denotes the exporting firm, j the trading partner, k the product and t the time (year). $ln(X_{ijkt})$, the dependent variable, is the value of exports (in logs) of firm i to market j for product k at a time t. Export values are measured in PKR millions. *US* is a dummy variable equal to one if an observation relates to exports to the US and recorded as zero for exports to an EU country, therefore identifying treated trade flows. Exports to the EU countries are the counterfactual in the regression, for which we provide further justification below. *TIME* captures the time period in which the treatment occurs: it is a dummy variable equal to one for the 2007–2014 period, and zero otherwise. Our regressor of interest is the term $IC3$, which is the interaction term $(US^{*}TIME)$. A significant coefficient for this regressor, β_3, would suggest that exports to the treatment group (US) relative to the control group (EU) have altered following the introduction of the IC3 program in 2007. ϵ_{ijkt} is an idiosyncratic error term. Throughout standard errors are clustered at the market–year level, the level of variation of regressor of interest. To this specification, we add a series of control variables that account for time-invariant firm–destination country characteristics, product- and common year-specific effects. This forms the baseline model that we use in much of the analysis.

We view the above difference-in-difference model as a naïve interpretation of the overall implementation of the IC3 program. In the rest of the analysis, we extend this baseline model to capture differences in its impacts across firms, capturing features of the implementation of IC3, and across time, as adjustments were made to the initial program.

2.3. Description of IC3

The validity of the difference-in-difference design relies on the allocation of the treatment, the use of the IC3 program for US trade, to be randomly assigned

from the perspective of Pakistan's exporters. To understand whether this assumption holds in the current context requires further background information on the IC3 program.

The integrated cargo containers control (IC3) program is part of the Secure Freight Initiative (SFI) run by the US Department of Homeland Security.[10] IC3 built on the Container Security Initiative and the Mega Ports Initiative, both started in 2001. The Container Security Initiative required the stationing of US Customs and Border Protection officials at foreign ports to scan containers based on risk assessment, whereas the Mega Ports Initiative aimed at scanning as many containers as possible at high-volume ports. As part of the earlier Container Security Initiative, US-bound commercial cargo containers could be randomly intercepted and diverted to Sri Lanka, Hong Kong or Oman for security scanning (European Commission 2009).[11]

IC3 began in April 2007. Its key feature is the mandatory requirement for all Pakistan–US exports to undergo security scanning before their arrival in the US.[12] The scheme was a partnership between Pakistan Customs and the US Customs and Border Protection. In Pakistan, the scanning technology to complete the 100% scanning requirement was made available at Port Qasim but also at ports in Sri Lanka, Hong Kong and Oman.[13] Scanning could be completed at Port Qasim or one of these other foreign ports. The Government of Pakistan provided the funds for land acquisition[14] at Port Qasim, whereas the US authorities provided the X-ray scanners, radio portal monitors,

10 This was formally distinct from the 100% scanning requirement imposed on all inbound US trade signed by President Bush on August 3, 2007, under the 9/11 Commission Act of 2007, which imposed a 100% scanning requirement for all countries by 2012. It was also separate to the SAFE Ports Act of 2006. Three pilot ports were selected for the scheme: Southampton (United Kingdom), Port Qasim (Pakistan) and Puerto Cortés (Honduras). A limited implementation was agreed for four additional ports (Singapore, Busan in South Korea, Salalah in Oman and Hong Kong in S.A.R. China). The insights from pilot schemes operated under the SAFE Ports Act were supposed to inform the provisions for freight scanning under the 9/11 Act, but that act was signed before the pilot schemes had begun (European Commission 2009).

11 These were in addition to standard domestic border clearance procedures, such as random physical inspections by Pakistan Customs and drug checks by the anti-narcotics force.

12 The agreement for IC3 was signed following a visit to Pakistan by President Bush in March 2006 and was due to open by December of the same year. However, this was delayed by around three months because of the late release of funds by the federal government (The News International 2007).

13 Megaports owned scanning equipment as part of their standard security arrangements.

14 10 acres of land were used for IC3.

communication systems and supporting technical assistance to Pakistan Customs.[15] Once cleared through Port Qasim, the cargo was placed on a secured site before being shipped. It was not subject to re-examination upon arrival at a US port, provided that the security seals on the container remained intact. Shipments sent via foreign ports for scanning took between two to six days longer to reach the US, depending on the destination port, compared with shipments sent directly through Port Qasim (see table 1). These arrangements and port capacity were left unaltered until 2011, when the scanning yard at Port Qasim was expanded to double its capacity and an off-dock terminal was developed near the Port of Karachi to collect US-bound export cargo containers and arrange their further transportation to, and processing at, Port Qasim.

From the perspective of Pakistan's exporters, the introduction of the IC3 program might reasonably be regarded as exogenous. The project was established as a result of the 9/11 attacks in the US and was imposed by the US in the wake of the prevailing broader international security situation, in particular with respect to Pakistan's neighbour Afghanistan. The Pakistan authorities had no influence over the design of the policy, no exemptions were offered for particular sectors and industries and Pakistan was not required to make investment in equipment or infrastructure beyond supplying the necessary land. Pakistan's exporters are also small on average, and because they produce often basic, standardized textile products, they have little or no market power in international markets. Therefore, they had no influence on the design or implementation of IC3.

2.4. Selection of a control group and tests for parallel trends

The scope and implementation of IC3 differs from many trade-related port or infrastructure projects, such as the construction of a new port or improvements in existing trade processing infrastructure, in that it effects are specific to destination market. IC3 influenced the processing of Pakistan's exports to the US (treatment group) only, whereas those to all other markets remained unaffected. Exports to non-US markets continued to be handled by ports across Pakistan, including inland (also known as dry ports), and the security arrangements were unaltered. Trade between Pakistan and other countries was potentially affected by concerns about the threat of global terrorism in this period, however, in particular that emanating from its neighbour Afghanistan. The most obvious example of this followed the attacks in London in July 2007. The counterfactual, therefore, controls for these common shocks to the demand for Pakistani produced goods. This empirical setting has another attractive feature: unlike in cross-country studies, there is no obvious variation in institutional quality, production patterns and endowment that might

15 Its building cost reached US$8 million (European Commission 2009).

explain the differential response of firms because both treatment and control groups are from the same country.

Besides the US, the major destinations of Pakistan exports include China, the EU and the United Arab Emirates (UAE). Although exports to these markets is comparable to that destined for the US, the structure of exports varies. In terms of the nature of products, the EU is closer to the US because these economies are key destinations for Pakistan's textiles and other finished goods.[16] Textiles constitute around 75% of the Pakistan export basket to these markets (see figure 3). The production process of these goods uses the same raw materials, machinery and equipment.[17] Given this, we use exports to the EU countries as the counterfactual.

Before proceeding to develop a formal estimation strategy, we test the key identifying assumption of parallel trends in the evolution of the control and treatment groups in the pre-treatment period. The following graphical and statistical analysis indicates that this assumption holds. Figure 4 plots Pakistan's total exports to the EU and US, the control and treatment groups respectively. The chart suggests that the evolution of exports to both markets was similar before the launch of IC3 but differed afterwards. Table A.1 in the online appendix presents the results of two sample *t*-tests on an annual basis, and shows that the difference in exports in this year, or indeed any other year, does not differ significantly between US and EU countries prior to IC3. We infer from this evidence that the assumption of parallel trends is satisfied and the EU represents a valid counterfactual group.

3. Estimation results

In this section of the paper, we present evidence on the effects of the IC3 program using the difference-in-differences model set out in section 2. We use these to get a sense of the aggregate effects of the IC3 policy and its implementation and then test the robustness of these results. We push further on the firms most affected by aspect of IC3 in the next section of the paper.

16 For comparison: exports to China mainly comprise raw materials and semi-processed goods, whereas those to the US are higher-value finished products. The UAE market attracts all kinds of products but exports to the UAE are not necessarily absorbed in that market, but may transit through its ports to other destinations.

17 The trade flow to the EU has not directly been affected by the introduction of IC3, although it may be indirectly affected if there is destination substitution. We address this potential concern in detail in the robustness analysis by decomposing the trade effect across single- and multiple-market firms as well as by using China as an alternative control on the assumption that export diversion to China, as a lower-income country, is more difficult. We control for the differences in product quality across markets in the estimations.

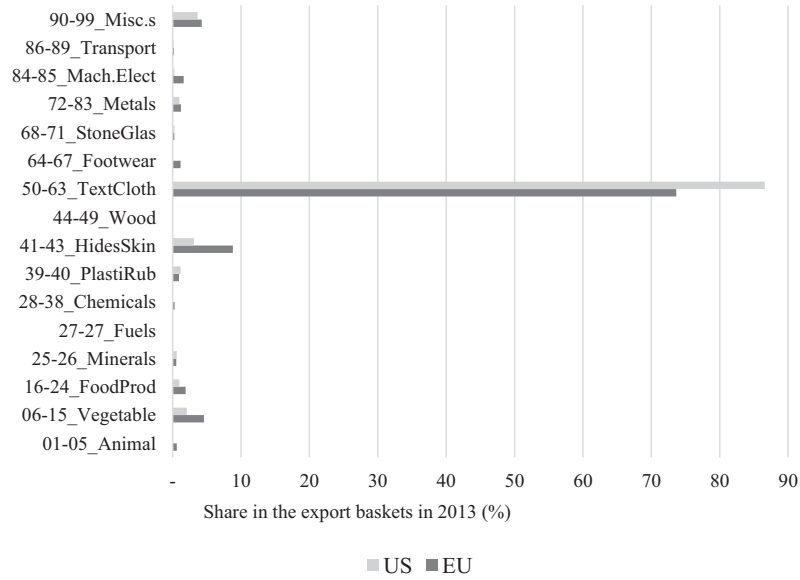

FIGURE 3 Composition of exports to the control (EU) and treatment (US) groups
SOURCE: Authors' construction using data set of Pakistan Customs

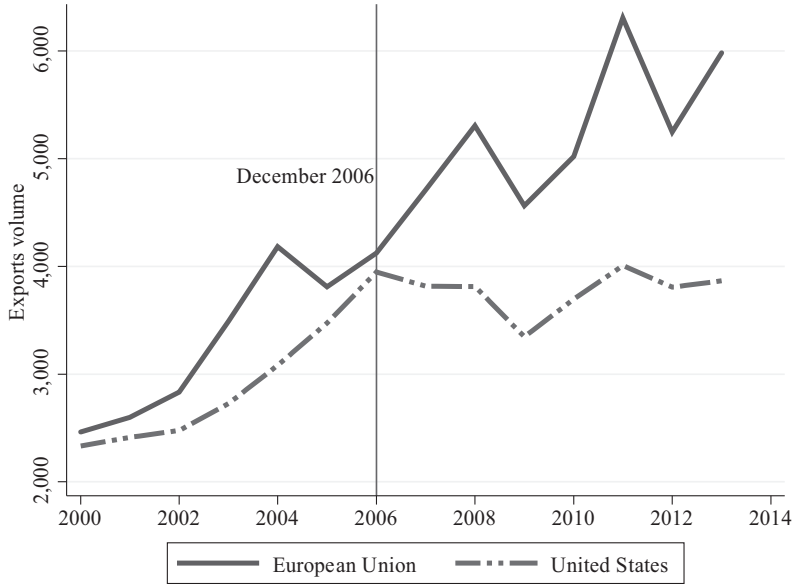

FIGURE 4 Pre- and post-treatment trends for the control (US) and treatment (EU) groups, 2000–2013
NOTE: Exports in millions of US dollars.
SOURCE: Pakistan Customs

3.1. Baseline estimations for IC3 implementation

The introduction of IC3 meant a change in the pattern of trade costs for Pakistan's exporters. The evidence presented in figure 3 suggests that the effect was to reduce exports to the US market. The growth of Pakistan's exports prior to the launch of IC3 to the US and EU is similar, but there is a marked deviation post-IC3 implementation. After 2007, the value of exports to the US remains largely unchanged until the end of the period, whereas exports to the EU continue to rise.[18] This evidence is consistent with an interpretation of rising overall trade costs for US trade arising from the implementation of IC3.

Regression 1 in table 3 is where we present the estimation results for the simplest form of the difference-in-difference model. In this regression, we report the standard treatment (labelled US), time and treatment*time (labelled IC3) variables from the DID model. The estimated coefficient on the treatment*time effect is negative and significant. According to the results from this regression, the introduction of the IC3 program policy in 2007 led to a fall in US exports relative to the counterfactual of 21% ($1\text{-}\exp^{-0.241}$).

In the remaining columns of the table, we compare the magnitude of this effect when we add various combinations of firm, destination, product and time effects that explain micro-level trade flows and might also be correlated with the response to the IC3 program. Of particular concern is the presence of unobservable firm, product and time effects that determine who and the type of products that are exported to the US market compared with the EU. To control for such selection bias, in turn we add a full set of dummy variables for firm–destination effects (regression 2); firm–destination and product (regression 3) effects; firm–destination, products and time effects (regression 4); firm–time effects, firm–destination and product effects (regression 5); product–time and firm–destination effects (regression 6) and firm–destination–product and year effects, where the products are measured at the eight-digit HS code level.[19]

The results in regression 2 indicate that the types of firms that export to the US market may differ in their time-invariant characteristics from those that export to the various EU markets. From the results, one might suggest that firms that export to the US are "better" than those who export to EU markets and this serves to bias upwards the estimated effect of the IC3 program. Relying on the within-firm–destination variation within the data, the results show that exports fell by an estimated 11% as a consequence of the IC3 program rather than the 21% from regression 1.

---

18 Formal testing also shows no break in trend for exports to the EU between the pre- and post-IC3 periods. This is consistent with any negative IC3 effect on exports to the US not being explained mainly by a source substitution or diversion effect that increased exports to the EU.

19 To estimate the model with high-dimensional fixed effects, we use the Stata command "reghdfe," as suggested in Guimaraes and Portugal (2010).

TABLE 3

Baseline estimates of the effect of Integrated Cargo Container Control (IC3) on US-bound exports

Regression	1	2	3	4	5	6	7
Dependent variable	Log of exports per firm by destination, by product and year						
IC3	−0.241***	−0.116***	−0.101***	−0.089***	−0.122***	−0.097***	−0.086***
	(0.019)	(0.018)	(0.017)	(0.017)	(0.025)	(0.017)	(0.029)
US	0.598***						
	(0.017)						
$TIME_{2007–2014}$	−0.273***	0.027***	0.004				
	(0.010)	(0.010)	(0.012)				
Additional controls							
Firm–destination FE	No	No	Yes	Yes	Yes	Yes	No
Products FEs	No	No	No	Yes	Yes	No	No
Year FEs	No	No	No	No	Yes	No	Yes
Firm–year FEs	No	No	No	No	No	No	No
Product–year FEs	No	No	No	No	No	Yes	No
Firm–destination–product FEs	No	No	No	No	No	No	Yes
R^2	0.009	0.473	0.547	0.561	0.607	0.575	0.792
Observations	606,351	606,351	589,486	589,486	570,065	580,713	334,333

NOTES: Robust standard errors clustered at market–year level are in parentheses. These coefficients were obtained using Stata/SE 13. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The estimates in the column for regression 4 are used as a baseline in subsequent robustness checks. FE = fixed effect.

As already noted, the type of products that Pakistan exports to the US and EU is similar. It is then perhaps of little surprise that controlling for product characteristics, even at the eight-digit HS code level in regression 3 has relatively little effect on the estimated effect of the IC3 program. Again the estimated effect of IC3 is close to 10%. In regression 4, we account for the presence of shocks to world trade that are year-specific but are common across the US and EU as export markets for Pakistan. In the post-IC3 time period, most obviously, this captures the effects of shocks to world trade associated not only with the global financial crisis and falling world demand but also with any effects from the war with neighbouring Afghanistan. It may also capture common movements in the demand for exports from Pakistan owing to changes in its perceived terrorist threat. These are included along with firm–destination and product fixed effects. Again, we find that this has some modest effect on the size of the estimated effect from the IC3 program, although the effect remains negative and statistically significant at conventional levels.

In regression 5, we consider the possibility of omitted variable bias at the level of the firm further by controlling for time-varying changes to firms that may affect trade (alongside product effects). These firm–time effects could include unobservable changes to the management and organization of the firm that affect all exports by that firm, shocks to their productivity or heterogeneity in the effects of the global financial crisis across firms. In this regression (regression 5), the effects of IC3 are identified from the within firm–year and firm–destination variation in the data. Despite the rather demanding nature of this regression specification, we continue to find evidence that trade from Pakistan to the US was negatively affected by the introduction of the IC3 program, where the estimated effect is if anything slightly larger than in regression 4.

In regression 6, we control for differences in the response of different products to common shocks by adding product–year dummies.[20] Again, despite the large number of dummy variables that are added to the regression in this model, the effect of IC3 is found to be negative and the magnitude of the effect is similar to that already reported. Finally, in regression 7, we control for any observable or unobservable time-invariant differences in the types of products that are exported by a given firm to the various US and EU markets by adding firm–destination–product fixed effects. In this regression, we lose many

20 For instance, Pakistan's textile exports to both the US and EU before 2005 (and at least two years before the implementation of IC3) had been subject to quota controls under the Multi-Fibre Arrangement (MFA), though subject also to liberalization over a period after 1995. Fugazza and Conway (2010) identify these quotas as being binding in both the US and EU in the case of Pakistan, in which case, the elimination of quotas may have induced differential expansion paths from 2005. This is not evident in Pakistan's total exports to the US and EU (see figure 3), but regression 6 in table 3 offers further reassurance the measured IC3 effect is not capturing delayed MFA liberalization effect.

observations because we cannot estimate the firm–destination–product effects for the firm–product combinations that appear only once in the data. The evidence from this regression suggests that the introduction of IC3 reduced exports from Pakistan to the US by a little less than 8%.

It should be noted that any serial correlation in exports to specific markets might tend to downwardly bias the standard errors on the IC3 variable in table 3, which are clustered at the market–year level. We can confirm, however, that the significance level on IC3 is sustained if the standard errors are clustered at the market level only. Note also that, as part of the later robustness analysis, we explicitly allow for the possibility of serial correlation by collapsing the time series data to simple pre- and post-treatment observations.

3.2. Robustness

We consider now some further issues around the robustness of the baseline results in table 3. Of the various regressions in table 3, we use regression 4 as the baseline, controlling for firm–destination, product and year effects. This noticeably reduces the magnitude of the coefficient compared with regression 1, but the coefficient on IC3 from this specification remains robust to the inclusion of other combinations of control variables.

The first-difference estimator is often proposed as part of the robustness testing for the difference-in-difference estimator because it relies on weaker exogeneity assumptions and is more efficient when the error term is serially correlated (Baier and Bergstrand 2007). Demir and Javorcik (2014) adopt a similar approach in firm-level estimations in order to account for any difference in pre-shock trends. Moreover, first-differencing of data takes account of the specific firm–product time-invariant factors, such as firms' experience of exporting a product to a given destination, and addresses any concerns about the non-stationarity of the series. We report the results from the first difference model as regression 1 in table 4. The results in table 4 provide support for our baseline findings because the coefficient of interest bears the expected signs and is statistically significant at the 1% level. The magnitude of the drop in trade explained by IC3 is larger than the baseline estimation at 11%, but is in the range of the estimates found in table 3.

As part of the robustness of difference-in-difference estimates Betrand et al. (2004) also recommend collapsing the time series data to a single pre- and post-treatment period to account for the problem of serial correlation when there are repeated observations. We report the results from this as regression 2 in table 4. Our findings again appear robust to this issue and if anything the magnitude of the effect of the IC3 program increases compared with the estimates in table 3.

In table 3, we controlled for the possibility that firms were affected by shocks differently using firm–time effects in regression 5, and that products had different product cycles by introducing product–time effects in regression 6. We did not, however, allow for the possibility that the timing of

shocks, such as the financial crisis, led to different policy responses and the differential pace of recovery across the EU and US. That is shocks had a market-specific dimension. To address this concern, we control for import demand in the regression.[21] The coefficient of interest in this regression (reported as regression 3 in table 4) remains negative and statistically significant at the 1% level, while the import demand variable has a significant and positive effect as expected.

Next we consider the role of the counterfactual in the regression. From the description of the IC3 program, a first concern is that the counterfactual may itself be contaminated by the introduction of IC3 because some exporters diverted efforts to serving the EU market. If this occurs, then it would tend to exacerbate the difference in trade to US and EU markets and increase the magnitude of the trade effects of IC3 in our regressions. To consider the plausibility of this argument, we separate firms that exported just to an EU country or the US (single destination exporters) from those that served both the US and EU. On the assumption that there are fixed or sunk costs of exporting, we would expect that the single-destination exporters should be less able to divert trade across destinations. That is, we would expect the effects of the IC3 program to be smaller when we consider single destination exporters and larger for firms that serve both markets.

We report the results comparing outcomes for single-destination exports in regression 4 and exporters who already served both the US and EU markets in regression 5. We find the expected pattern in the results, the effect of IC3 is larger for firms that had the greatest possibility of diverting trade from the affected US market to the EU market. However, in both cases, the effect of IC3 remains negative and statistically significant and, reassuringly, the magnitude of the decline in trade for the single destination exporters is not dissimilar to in the baseline regressions. Trade by firms serving just the US market or an EU country fell relative to firms serving just the EU market by 7%, close to previous estimates, whereas for firms serving both US and EU markets trade fell by 12% in the post-IC3 period.

In regression 6, we explore the use of an alternative counterfactual for US trade. IC3 targeted exclusively Pakistan's US-bound exports, whereas those to other markets, including China, were not subjected to screening. Although there is less similarity in market conditions and product mix between the US and China than is the case for the US and EU, using China as an alternative counterfactual offers two specific advantages. First, exports to China were not affected by the conclusion of the Agreement on Textiles and Clothing (ATC) in 2005, which might have influenced textiles exports to the EU market due to the removal of the quota under ATC. Second, the demand for Pakistani exports into the US and China are likely to be different such that the scope for

21 This variable is measured by net imports in market j (US) less imports by j from Pakistan in product k at time t.

TABLE 4

Robustness of the effects of IC3 program

Regression number:	1	2	3	4	5	6	7	8
Remark	First-differenced	Single pre- and post-IC3 periods	Adding import demand	US or EU exports	US and EU exporters	China as counterfactual	Comtrade data for Pakistan	Comtrade data for India
Dependent variable	Log of exports per firm, by destination, by product and year					Log of exports by destination, by product and year		
IC3	−0.111***	−0.142***	−0.081***	−0.069**	−0.125***	−0.207***	−0.281***	0.003
	(0.027)	(0.021)	(0.019)	(0.030)	(0.022)	(0.066)	(0.036)	(0.037)
Import demand			0.047***					
			(0.005)					
Additional controls								
Firm–destination		Yes	Yes	Yes	Yes	Yes	No	No
Products		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year		No	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.000	0.555	0.558	0.596	0.552	0.560	0.740	0.734
Observations	185,989	380,549	576,607	261,850	319,964	160,157	39,604	87,568

NOTES: Robust standard errors are in parentheses. These coefficients were obtained using Stata/SE 13. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The coefficients for other regressors and fixed effects are not reported because they are not of direct interest. The first treatment indicates the effect of the initial shock, and the second treatment shows the effect of subsequent remedial measures. The number of observations varies across columns because Stata drops singletons in columns 2 and 3. The estimations control for import demand in both markets to account for the differential effect of the financial crisis on the EU and US markets. The import variable captures total importations of the EU and US from the world less their imports from Pakistan.

exporting firms to switch markets following IC3 is more limited than in the EU case. Concerns about trade diversion contaminating the counterfactual are, therefore, less likely to apply.[22] Regression 6 in table 4 indicates that the drop in trade between Pakistan and the US is even larger when using trade with China as the counterfactual than using Pakistan's trade with the EU as a control group. In the post-treatment period, Pakistan's US-bound exports relative to China drop by 19%, on average.

As a further exercise in this section, we conduct a placebo test where we consider trade between India, the US and the EU. By so doing, we seek to test whether the difference in the pattern of trade we observe between Pakistan–US and Pakistan–UE in the post-IC3 period might be explained by a more general difference in trade into the US and EU markets. To conduct this test, we use a different data set, the UN Comtrade database, where products are now measured at the six-digit HS code level. While this exercise also allows us to test the robustness of our findings to the use of an alternative data source, the disadvantage of using such data is that they do not allow us to control for time-invariant differences in the type of firms exporting to the US and EU markets. The results from regression 2 of table 3 suggest that this was an important difference for the magnitude of estimates of the effects of IC3.[23]

In regression 7, we first show the robustness of our results for Pakistan to the use of the UN Comtrade data. The difference in the different estimates shows that relative to the counterfactual of EU exports, Pakistan's exports to the US dropped by 24% on average. This difference is statistically significant at the 1% level. The effect is expected to be larger than those reported regression 4 in table 3 given the absence of firm-specific information in the UN Comtrade data and that it is close to the estimates in regression 1, where we also did not control for time-invariant unobservable firm–destination characteristics. This differs from the pattern found for Indian exports to the same markets over this time period reported in regression 8. Indian exports to the US were unaffected by the introduction of IC3 in India, compared with the counterfactual. Also important, the magnitude of the treatment effect in regression 8 is very close to zero in its overall magnitude, indicating that the treatment effect of IC3 is not poorly identified in the data.

In regression 1 in table 5, we extend the modelling of the implementation of IC3 to capture the 2011 port expansion at Port Qasim. We capture this by

22 We also formally conducted a parallel trends test for Pakistan's exports to China and the US in the pre-IC3 period in the same way as for the base results. The assumption of a parallel trend is satisfied.

23 We also find the coefficient on IC3 effect to be of very similar magnitude (−0.258) if we aggregate our own data on the same basis as we do the Comtrade data.

TABLE 5
Heterogeneity of the IC3 effect over time

	(1) All	(2) All	(3) Manufacturing only	(4) Manufacturing and selected countries
IC3 2007–2014	−0.114***			
	(0.017)			
IC3 2011–2014	0.091***			
	(0.015)			
IC3 2007–2014		−0.109***	−0.102***	−0.089***
		(0.019)	(0.019)	(0.024)
IC3 2010–2014		−0.011	−0.007	−0.003
		(0.017)	(0.017)	(0.021)
IC3 2012–2014		0.095***	0.087***	0.074***
		(0.016)	(0.016)	(0.020)
Firm–destination, product and year FEs	Yes	Yes	Yes	Yes
R^2	0.561	0.561	0.551	0.553
Observations	589,486	589,486	558,099	307,015

NOTES: Dependent variable is log of exports per firm, by destination, by product and year. Robust standard errors clustered at market–year level are in parentheses. These coefficients were obtained using Stata/SE 13. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. FE = fixed effect.

separating the effects of IC3 into pre- and post-2011 time periods. In the regression, the variable *IC3 2007–2014* is a dummy variable equal to one for the period 2007–2014, and zero otherwise, and *IC3 2011–2014* is also a dummy variable equal to one for the period 2011–2014, and zero otherwise. This latter variable, therefore, captures the additional effect of changes in the post-2011 time period arising from the expansion of port facilities at Port Qasim. The results in regression 1 demonstrate quite clearly that these investments in port capacity strongly attenuated the negative impacts of IC3 felt in the first part of the period. In the years from 2007 to 2011, exports fell by 11% compared with the counterfactual but fell by only 2.3% compared with the counterfactual in the 2012–2014 period.

In the remainder of table 5, we extend further the issue of consider the robustness of the results to the possibility that the effects of IC3 are confounded by the escalation into war in Afghanistan and the increase in troop numbers under International Security Assistance Force (ISAF) and US command in 2006. The coincident timing of IC3 with the escalation into war in neighbouring Afghanistan, in which the US was heavily involved compared with many European countries, may suggest an upward bias in the (absolute) estimated magnitude of the current estimates of IC3.

We use the historical narrative on the evolution of war in neighbouring Afghanistan and the involvement of different countries within ISAF to

consider a number of complementary approaches to this question. In regression 2 in table 5, we consider the fact that there were sharp increases in violence in Afghanistan after 2007 and a surge in troop numbers in 2009, with further increases in the years up to 2011, ending with the death of Osama bin Laden in Pakistan on May 1, 2011. If the war in Afghanistan has an important bearing on the results found in previous tables, we would anticipate that this would demonstrate itself by instability in the IC3 variable across time. While IC3 and Afghan war events in 2007 and 2011 coincide, the upsurge in violence and the expansion of troop numbers in 2009 does not. If the Afghan war confounds in some way with IC3 or the adoption of other security measures against Pakistan, we would expect the effect on trade to be significantly different in these years. In regression 2, we separate these into the period from the beginning of the war to the surge in troop numbers in 2009 and the period up to the death of Osama bin Laden, in 2011. We again express these using shift dummies such that for example, the 2010–2011 period is measured relative to the 2007–2009 period. We find no evidence of such a difference, which we interpret as supporting the view that the Afghan war does not contaminate our analysis of IC3.

An alternative explanation of our findings might occur because Afghanistan is a landlocked country and the regional war may have led some exporters to use Pakistan as a route to ports, possibly using Pakistan's truck or retailers. We investigate this point by exploiting the difference in the type of products exported by both countries, with a large part of Pakistan's exports being textiles and other manufactured goods and Afghanistan's being agricultural products. To capture this difference, we focus on exports of manufactured goods only. Because the incentive to use Pakistan to carry its trade is again likely to have been altered over the period of the war, we combine this with the same time periods as we do in regression 2. The results from this regression (reported as regression 3) again provide no support for the view that this explains our previous findings, with very little change in the magnitude of the estimated effects of IC3 compared with regression 2.

Finally, we draw on the fact that participation in ISAF was uneven across European countries. In regression 4 in table 5, we include within the counterfactual the European countries (Denmark, France, Netherlands, Norway and the UK) that, like the US, participated in the Afghan war throughout the period and therefore would be subject to the same "war effect." If participation in the Afghan war by the US spills over into its trade with Pakistan in some way, then we would expect a similar effect for these European countries, and thus such effects are removed when we use these as the counterfactual for Pakistan–US trade. Again, we find no support for the view that our previous findings capture any effect of the Afghan war. The magnitude of the estimated effect of IC3 between 2007 and 2009 in regression 5 is 9% compared with 11% in regression 2 and 10% in regression 4, when we use only manufactured goods. The results also display the same pattern across time.

4. Extended analysis: Heterogeneity across firms

The results in tables 3 and 4 assume that the effects of the IC3 were homogenous across firms. Compared with the (pre-IC3) system of randomly intercepting freight and diverting it to a foreign port, expected beyond-the-border time costs fell following the introduction of IC3 for freight continuing to be sent via Port Qasim or being switched to Port Qasim, freight now being sent with certainty directly to the US once it cleared Pakistan customs.[24] The documentation on the creation of a pre-shipment scanning facility prior to its introduction describes the program as therefore consistent with the idea of trade facilitation.[25] At-the-border and behind-the-border costs rose, however, for some exporters. Exporters continuing to export after IC3 from Port Qasim ("incumbents") or switching to export from Port Qasim post-IC3 ("switchers") faced increased costs because of the time spent scanning at the port and because of congestion at the port gates due to the concentration of scanning equipment at this single location.[26] We summarize this information in table 6, where we summarize the change in trade costs according to the pre- and post-IC3 use of Port Qasim or a different post (labelled other)

As the table summarizes, for those exporters that continued to use ports other than Port Qasim ("stayers"), beyond-the-border trade costs rose compared with the pre-IC3 scheme because of their required diversion to a foreign port for scanning. This is demonstrated by the increased maritime distances and sailing times given in table 1, but also arose because of the time spent at the foreign port for scanning. For freight routed this way, at-the-border and

24 The implementation of IC3 required that all full-container-load cargo be switched to Port Qasim for scanning. Less-than-full loads could continue to use ports other than Qasim.

25 Documents of the national customs authorities, as well as of the Pakistan Trade Policy Review (World Trade Organization 2007), describe it as a step towards facilitating trade by curtailing vessel sailing time to the US, eliminating transhipment requirements at intermediary ports for scanning and simplifying procedural formalities at the port of origin and destinations, in addition to ensuring the security of the supply chain.

26 Port Qasim is relatively poorly connected with the hinterland compared with the Port of Karachi, which is the main sea port of Pakistan. Port of Karachi also has better port infrastructure and handling facilities. Moreover, the major support services, such as shipping agents and freight forwarders, are located near the Port of Karachi. The IC3 scanning yard at Port Qasim is located outside the main port terminal. This means there is a need for unloading, handling and internal transportation, which further increases the costs, in addition to causing delays. Because Port Qasim is connected to the main road network through Karachi, cargo vehicles have to wait in the daytime to ply through the mega city of 22 million people. To avoid traffic congestion, heavy traffic is allowed to pass through the city only after 11 p.m.

TABLE 6
Impact of IC3 on trade costs for firms

"IC3" impact of trade costs	Port Qasim pre- and post-IC3 (incumbents)	Other port pre-IC3, Port Qasim post-IC3 (switchers)	Other port pre- and post-IC3 (stayers)
Up to the border	No change	Increase due to increased distance to port	No change
At the border	Increase due to congestion at Port Qasim	Increase due to congestion at Port Qasim	No change
Beyond the border	Fall due to removal of risk of diversion to international port	Fall due to removal of risk of diversion to international port	Increase due to requirement to complete scanning at international port
Overall	Ambiguous	Ambiguous	Increase

behind-the-border trade costs were unaltered. In comparison, for freight that had previously been routed through an alternative home port but was now switched to using Port Qasim, behind-the-border trade costs rose as exporters faced the further internal distance and therefore additional cost of transferring their cargo to Port Qasim rather than to Karachi or to their other previous choice of shipment (see table 2).

A natural question that follows from these differential changes in behind-the-border and beyond-the-border trade costs for different types of exporting firms is how much trade continued to use other ports in Pakistan and how much switched to using Port Qasim? The percentage of the total value of exports to the US using of Port Qasim versus the alternative ports, including Port of Karachi, dry ports and airfreight for 2005 to 2014 is shown in figure 1. Following the introduction of IC3, the percentage of export value using the Port of Karachi fell, although this appears to be driven by a rise in the use of dry ports and airfreight as well as Port Qasim. This is consistent with evidence from a European Commission report into the US scanning of freight globally, including the project in Pakistan, which noted limited immediate switching of freight to Port Qasim. Freight transferred through dry ports required security clearance from the US, but this could be done at Port Qasim or elsewhere. The share of trade using Port Qasim rose more quickly in the years 2009 and 2010, such that by 2011 it accounted for over 65% of total exported cargo to the US.

In an extension to the empirical analysis, we study the trade effects separately for those firms that had used Port Qasim and non-Port Qasim ports prior to introduction of IC3. For this, we create three sets of firms according to their use of exporting locations in the 2006 data: those that previously used Port Qasim exclusively and continued to export from Port

Qasim post-IC3 ("incumbents"); those that had previously used the Port of Karachi, dry ports and air freight and changed to Port Qasim ("switchers"); and those that continued to export from other than Port Qasim ("stayers"). Note that this separation of firms allows us also to implicitly explore the effects of an alternative counterfactual. "Incumbents" and "switchers" are firms that are affected by both the 100% scanning requirement and the use of pre-shipment clearance, while "stayers" are firms that are affected by the 100% scanning requirement only. Our estimate of the IC3 effect in the base analysis is a weighted average of the scanning requirement alone and joint scanning and pre-shipment clearance effects. The estimated trade effect for the "stayers" (in absolute terms and relative to that for the non-stayers) allows us to comment on the alternative counterfactual: What if 100% scanning had been applied without the creation of the pre-shipment clearance facility at Port Qasim?

In table 7, we group firms according to this classification of exporting firms and to distinguish between the average post-IC3 effect and the effect of IC3 after the expansion of Port Qasim facilities in 2011. In these regressions, the variable *IC3 (First treatment)* is a dummy variable equal to one for the 2007–2014 period, and zero otherwise, and *IC3 (Second treatment)* is also a dummy variable equal to one for the 2011–2014 period, and zero otherwise. This latter variable, therefore, captures the additional effect of changes in the post-2011 time period arising from the expansion of port facilities at Port Qasim.

Regressions 1 to 3 in table 7 report regressions for the modified treatment effect for each of the groupings of exporting firms. We anticipate that an increase in total (behind-the-border and beyond-the-border) trade costs was least likely for "incumbents" because any increase in costs arising from IC3-induced congestion at Port Qasim would tend to be offset by expected lower beyond-the-border trade costs due to the avoidance of diversion for scanning on route to the US. By contrast, "stayers" must experience higher trade costs; although behind-the-border costs are on average unaltered, beyond-the-border costs must have risen because all shipments were diverted to an international port for scanning post-IC3. Like for "incumbents" (and for the same reason), beyond-the-border trade costs fell for "switchers" as a result of IC3; but this may have been more than offset by the effects of switching on behind-the-border trade costs, increases in internal transport distances to the port of exporting and increased delays due to port congestion pushing up this element of trade costs.

The results in table 7 are in line with the expected heterogeneity of the IC3 effect across exporter types and over time. We find no significant IC3 effect on the exports of "incumbents" (regression 1) but a significant negative effect of IC3 on both "switchers" (regression 2) and "stayers" (regression 3). The negative IC3 effect on exports is in fact greater for "stayers" than "switchers." Indeed, the negative effect on "switchers" is shown to be reduced post the expansion of port facilities and capacity at Port Qasim in 2011. Note also the

TABLE 7

Heterogeneity of the IC3 effect across firms and over time

	(1) Incumbents	(2) Switchers	(3) Stayers
First treatment_2007–2014	−0.205	−0.151***	−0.361**
	(0.144)	(0.023)	(0.169)
Second treatment_2011–2014	0.001	0.082***	0.002
	(0.028)	(0.017)	(0.113)
Firm–destination, product and year fixed effects	Yes	Yes	Yes
R^2	0.631	0.530	0.713
Observations	147,449	365,566	7,665

NOTES: Dependent variable is log of exports per firm, by destination, by product and year. Robust standard errors clustered at market–year level are in parentheses. These coefficients were obtained using Stata/SE 13. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The three sets of firms indicated in the column heads are constructed as per the use of exporting locations in the 2006 data: incumbents are those that previously used Port Qasim exclusively and continued to export from Port Qasim in the post-IC3 period; switchers are those that had previously used the Port of Karachi, dry ports and air freight and changed to Port Qasim; and stayers are those that continued to export from other than Port Qasim.

highly credible finding that there is not a significant second treatment effect in the case of "incumbents" and "stayers." Firms continuing to export from other than Port Qasim ("stayers") would not be expected to be affected by the expansion of Port Qasim's facilities. "Incumbents" could have been affected by the improvements in 2011 but were not, in fact, found to be significantly affected by IC3 after 2007 (though the pattern of signs on the first and second treatment effects is consistent with an improvement story).[27] Note, finally, the much larger negative trade effect for "stayers" than for non-stayers ("incumbents" and "switchers"). It is evident from this that 100% scanning without the pre-clearance facility was likely to have had been much more trade-deterring than with this facility. This finding is not inconsistent, however, with the finding that the implementation of IC3 was not trade-facilitating overall for "incumbents," "switchers" or "stayers." Indeed, we find that IC3 was trade-deterring for "switchers" and "stayers."

27 As a final check on the robustness of our findings, we explored the IC3 effect (for the whole post-2007 period and the expansion of Port Qasim facilities in 2011) using the number of shipments rather than export values as the dependent variable. The DID estimates, using the same methodology as for the main results, show a statistically significant (at the 1% level) drop in the number of shipments to the US relative to the EU after the first intervention and rise in the same after the second intervention, which is consistent with our main results.

5. Summary conclusions and policy implications

The US has aimed over the last decade to reduce the threat to national security from containerized cargos shipped to its ports. In the case of the IC3 program introduced in 2007, the US sought not to reduce the security threat by requiring the comprehensive scanning of imports from Pakistan but also to reduce "beyond-the-border" trade costs for Pakistan exporters by providing scanning technology in Pakistan (thereby avoiding the need for the diversion of ships to international ports with scanning facilities). The program was represented ex ante as being both pro security and trade-facilitating. The present study finds, however, that IC3 actually reduced Pakistan's exports to the US in the 2007–2014 period. This finding is robust to alternative estimation methods and alternative controls, including controls made possible by the use of firm- and destination-level export data. In particular, the scale of the export reduction effect of IC3 is upwardly biased if aggregate trade is used and does not allow for the control of firm–destination-specific effects, with specific firms in Pakistan selecting or having acquired the attributes required for the US export.

The finding of net export reduction is consistent with raising total trade costs for Pakistan exporters to the US, relative to their trade costs to other destinations and in particular to the control destination of the EU. This might be considered an unexpected outcome because the provision as part of IC3 of a scanning facility in Pakistan avoided the diversion of ships to international ports and reduced international shipping distances and shipping times between Pakistan and US ports. The simultaneous reduction in "beyond-the-border" trade costs and increase in total trade costs is possible only if IC3 also led to an increase in "behind-the-border" trade costs. We find this we occurred because of a specific feature of the design of the IC3 program, with scanning facilities made available only in Pakistan at one port, namely Port Qasim.

We observe from our data the switching in the post-IC3 period of some firms' US-bound exports via Port Qasim. These exporters who switched to Port Qasim had to incur increased internal transport costs associated with greater distances travelled to this port. The increase in exporting from Port Qasim also resulted in greater congestion in and around the port and to slower clearance through the port for those continuing to export from Port Qasim and for those switching to Port Qasim. Indeed, these by-product effects of the increased use of Port Qasim by exporters to the US would have reduced the incentive for some exporters to switch to this port. Again, from the data, we observe firms that continued to export via other Port Qasim, including the Port of Karachi and many of the exporters from the Karachi area. For these firms, "behind-the-border" trade costs were not directly affected by IC3, but the 100% scanning requirement meant that diversion via an international port with scanning facilities was now certain rather than possible. Average or expected beyond-the-border trade costs rose, in fact, for this group of "stayers." Further, we find that the trade-deterring effect for "stayers" was larger

than it was for firms that switched to using the pre-shipment scanning facility, indicating that pre-shipment clearance ameliorated the effects of 100% scanning but did not eliminate them.

The present findings emphasize the need to recognize both behind-the-border and beyond-the-border trade cost effects in the design of measures to increase security. This may well be particularly important in the context of developing countries, for whom the infrastructure and institutional capacity to implement new security measures is constrained. They also demonstrate the benefits of using disaggregate, firm-level data to model and measure the trade effect of such security measures because these data allow the investigator to explore the heterogeneity of the trade effect across firms in different locations who may or may not export from the same port before and after the implementation of the program. In the present context, we show that firms already exporting from Port Qasim pre-IC3 ("incumbents") did not experience a significant impact on their exports due to IC3. By contrast, for those exporters who switched to exporting from Port Qasim ("switchers") and those continuing to export from other than Port Qasim ("stayers"), IC3 had a significant negative effect on exports, though the negative effect for "switchers" was reduced post-2011 by the expansion of facilities at Port Qasim.

The present findings have policy implications for the ongoing drive to deploy similar technologies aimed at ensuring the security of the global supply chain. They show how adding another layer of security to already very thick national borders can influence the behaviour of exporting firms and disrupt existing trade flows. In the wake of the emerging security situation in different parts of the world, the implementation of arrangements similar to IC3 at other ports may also have the unintended effect of reducing rather than facilitating trade. This implies that policymakers need to consider domestic, as well as international, aspects of trade costs and have a comprehensive view of the nature of trade costs. This is so for policy makers in all countries, but it is likely to be particularly relevant in the context of developing countries.

Supporting information

Supplementary material accompanies the online version of this article.

References

Anderson, J.E., and E. Van Wincoop (2003) "Gravity with gravitas: A solution to the border puzzle," *American Economic Review* 93(1), 170–92

—— (2004) "Trade costs," *Journal of Economic Literature* 42(3), 691–751

Arkolakis, C. (2010) "Market penetration costs and the new consumers margin in international trade," *Journal of Political Economy* 118(6), 1151–99

Baier, S.L., and J. H. Bergstrand (2007) "Do free trade agreements actually increase members' international trade?," *Journal of International Economics* 71(1), 72–95

Bernhofen, D.M., Z. El-Sahli, and R. Kneller (2016) "Estimating the effects of the container revolution on world trade," *Journal of International Economics* 98, 36–50

Bertrand, M., E. Duflo, and S. Mullainathan (2004) "How much should we trust differences-in-differences estimates?," *Quarterly Journal of Economics* 119(1), 249–75

Carluer, F., Y. Alix, and O. Joly (2008) *Global Logistic Chain Security: Economic Impacts of the US 100% Container Scanning Law*. Caen: Éditions EMS

Carrère, C. (2006) "Revisiting the effects of regional trade agreements on trade flows with proper specification of the gravity model," *European Economic Review* 50(2), 223–47

Demir, B., and B. Javorcik (2014) "Grin and bear it: Producer-financed exports from an emerging market," mimeo, Oxford University

Djankov, S., C. Freund, and C. S. Pham (2010) "Trading on time," *Review of Economics and Statistics* 92(1), 166–73

Donaldson, D. (2018) "Railroads of the raj: Estimating the impact of transportation infrastructure," *American Economic Review* 108(4–5), 899–934

European Commission (2009) *The Impact of Scanning of U.S.-Bound Containers on Maritime Transport*. Brussels: Policy Research Corporation, Directorate-General for Energy and Transport

Feyrer, J. (2009) "Distance, trade, and income: The 1967 to 1975 closing of the Suez Canal as a natural experiment," NBER working paper no. 15557

Fugazza, M., and P. Conway (2010) "The impact of removal of ATC quotas on international trade in textiles and apparel," UNCTAD Policy Issues in International Trade and Commodities Study Series, no. 45

Government Accountability Office (2008) "Supply chain security: Challenges to scanning 100 percent of U.S.-bound cargo containers." Testimony before the Subcommittee on Surface Transportation and Merchant Marine Infrastructure, Safety, and Security; Committee on Commerce, Science, and Transportation; the U.S. Senate. Washington: United States Government Accountability Office. Available at `www.gao.gov/assets/gao-08-533t.pdf`

Guimaraes, P., and P. Portugal (2010) "A simple feasible procedure to fit models with high-dimensional fixed effects," *Stata Journal* 10(4), 628–49

Hummels, D. (2007) "Transportation costs and international trade in the second era of globalization," *Journal of Economic Perspectives* 21(3), 131–54

Meade, C., and R. C. Molander. (2006) "Considering the effects of a catastrophic terrorist attack," technical report no. 391, Rand Center for Terrorism Risk Management Policy. Available at `www.rand.org/pubs/technical_reports/TR391.html`

Mirza, D., and T. Verdier (2008) "International trade, security and transnational terrorism: Theory and a survey of empirics," *Journal of Comparative Economics* 36(2), 179–94

OECD (2005) *Container Transport Security Across Modes*. Report presented to the European Conference of Ministers of Transport (ECMT). Paris: OECD Publications Service

Pascali, L. (2017) "The wind of change: Maritime technology, trade and economic development," *American Economic Review* 107(9), 2821–54

The News International (2007) "The screening of US-bound containers to start in March." Accessed at `https://www.thenews.com.pk/archive/print/40230-screening-of-us-bound-containers-to-start-in-march`

World Customs Organization (2009) *Global Logistic Chain Security: Economic Impacts of the US 100% Container Scanning Law*. Brussels: World Customs Organization

World Trade Organization (2007) *Trade Policy Review: Pakistan*. WT/RTP/G/193, 10 December. Geneva: World Trade Organization